Searching for dark matter signals in the Galactic Centre region

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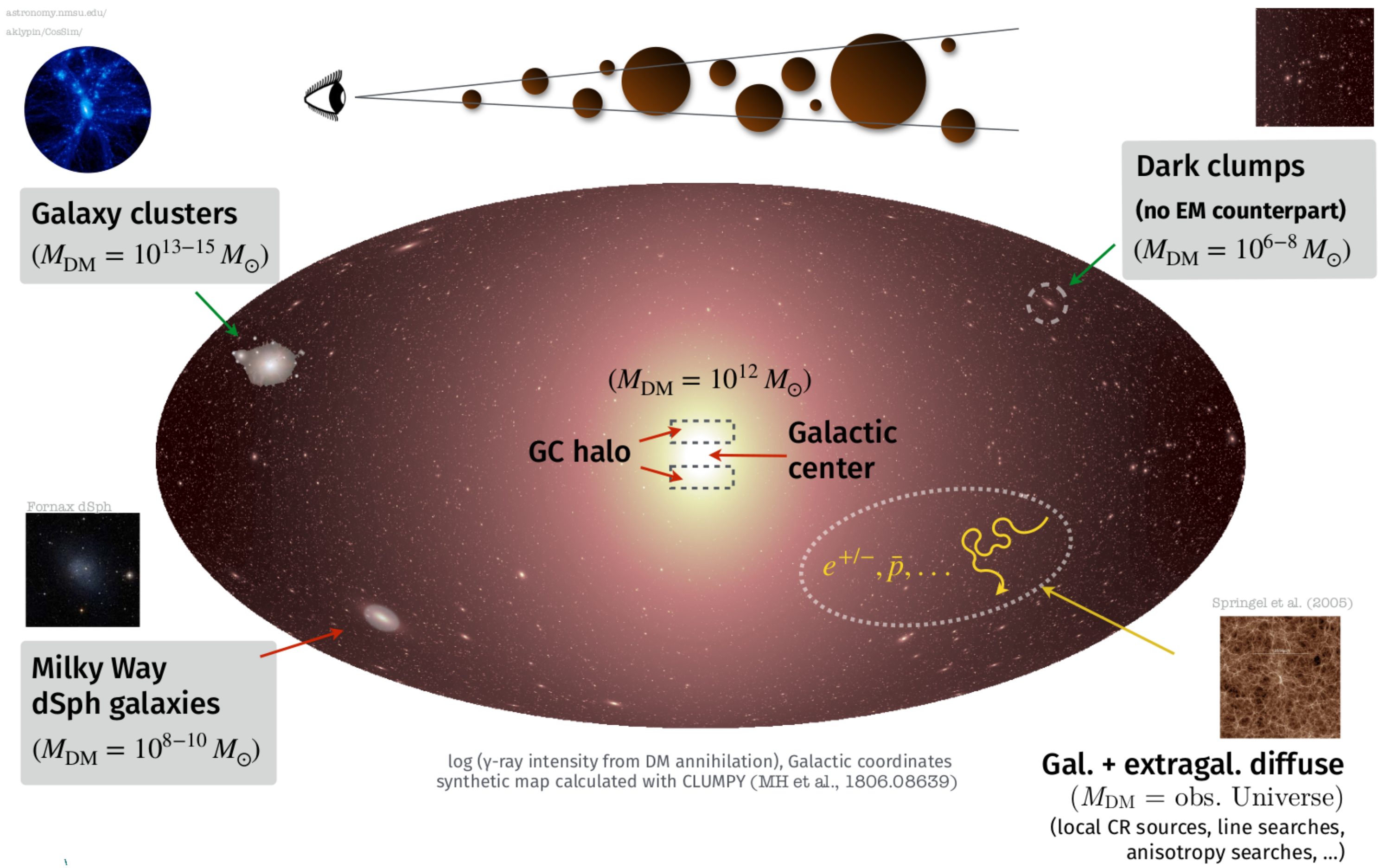
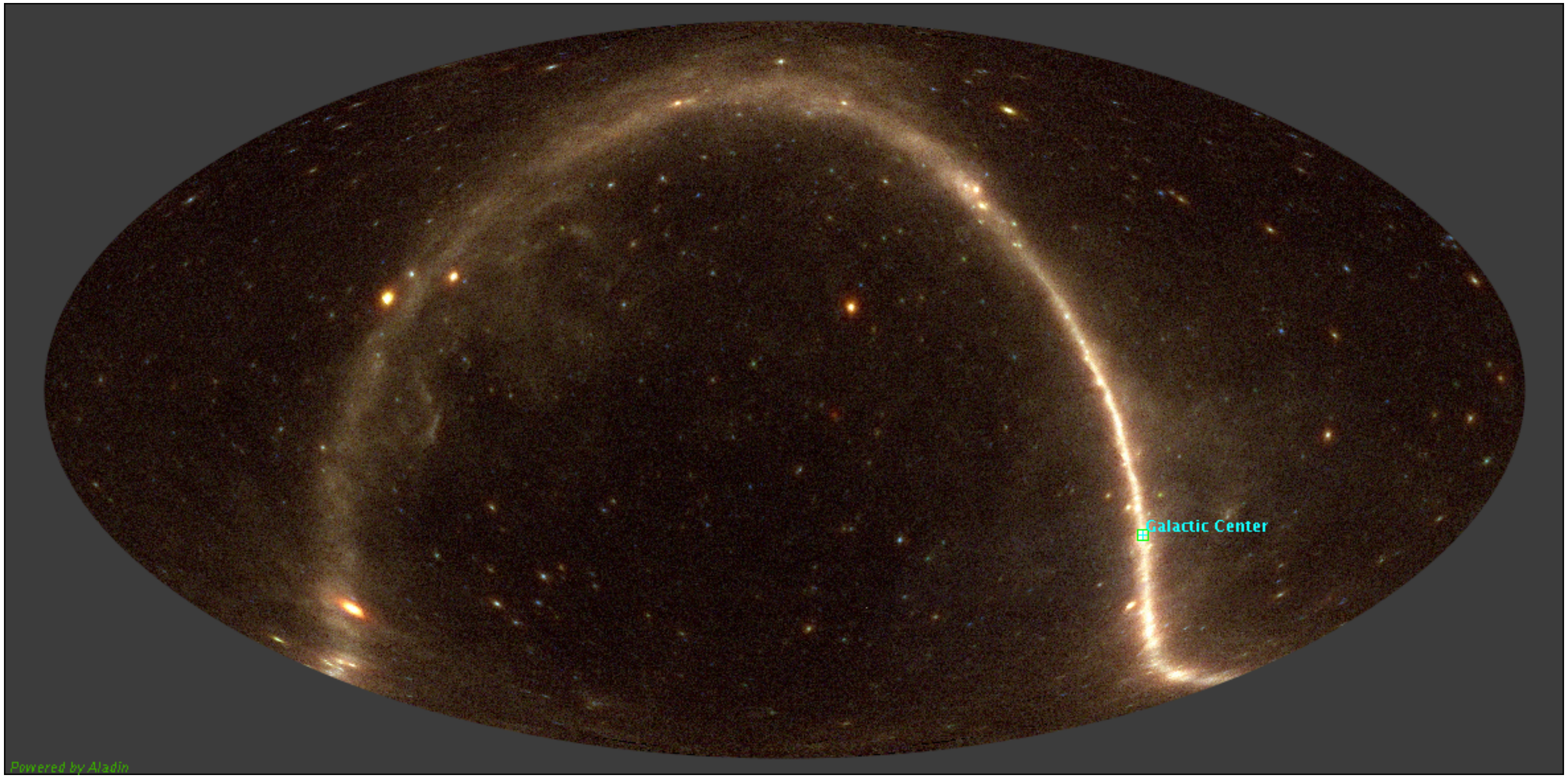
Why the Galactic Centre region?



Courtesy of M. Hütten

Why the Galactic Centre region is a good target for H.E.S.S.?



The H.E.S.S. experiment

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H.E.S.S. phase I

- 4 telescopes since 2003
- 960 PMT/camera
- Field of view: 5°
- Stereoscopic reconstruction

H.E.S.S. phase II

- 5th telescope in 2012
- 2048 PMT
- Field of view: 3.5°

Bibliography

This presentation is based on the 2 following publications by the H.E.S.S. collaboration:

- 07/2016: `https://arxiv.org/abs/1607.08142`
  Search for dark matter annihilations towards the inner Galactic halo from 10 years of observations with H.E.S.S.
- 05/2018: `https://arxiv.org/abs/1805.05741`
  Search for γ-ray line signals from dark matter annihilations in the inner Galactic halo from ten years of observations with H.E.S.S.

ON and OFF regions

254h of data between 2004 and 2014 (H.E.S.S. I phase)

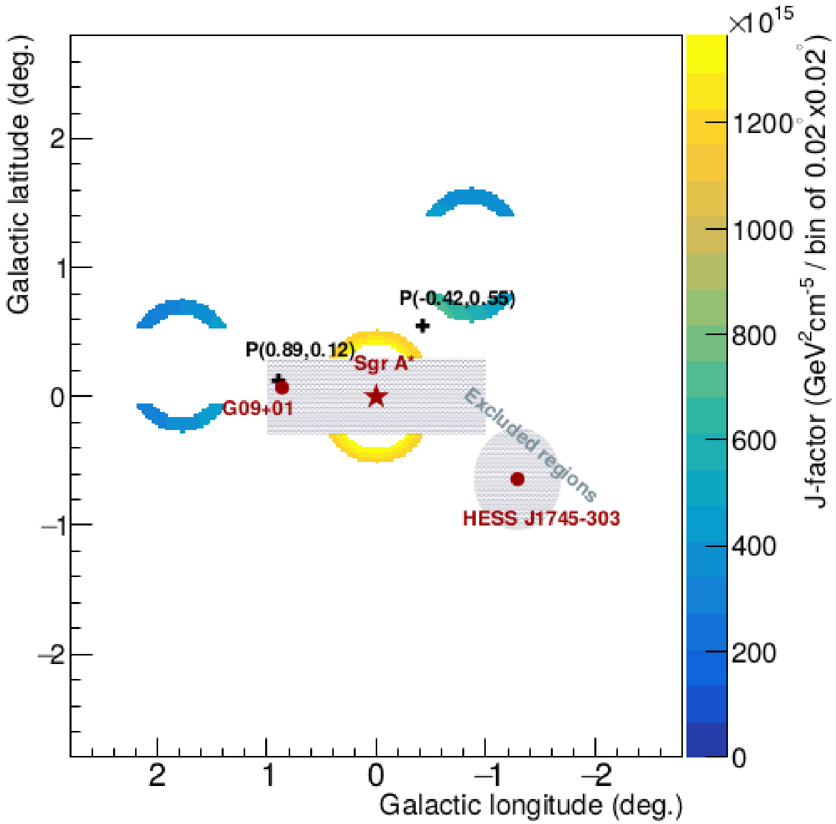
Telescope pointing positions between 0.5° and 1.5° from the GC

Mean zenith angle of 19°

ON and OFF regions

254h of data between 2004 and 2014 (H.E.S.S. I phase)
Telescope pointing positions between 0.5° and 1.5° from the GC
Mean zenith angle of 19°

ROIs are annuli of 0.1° width from 0.3° to 0.9° from the GC



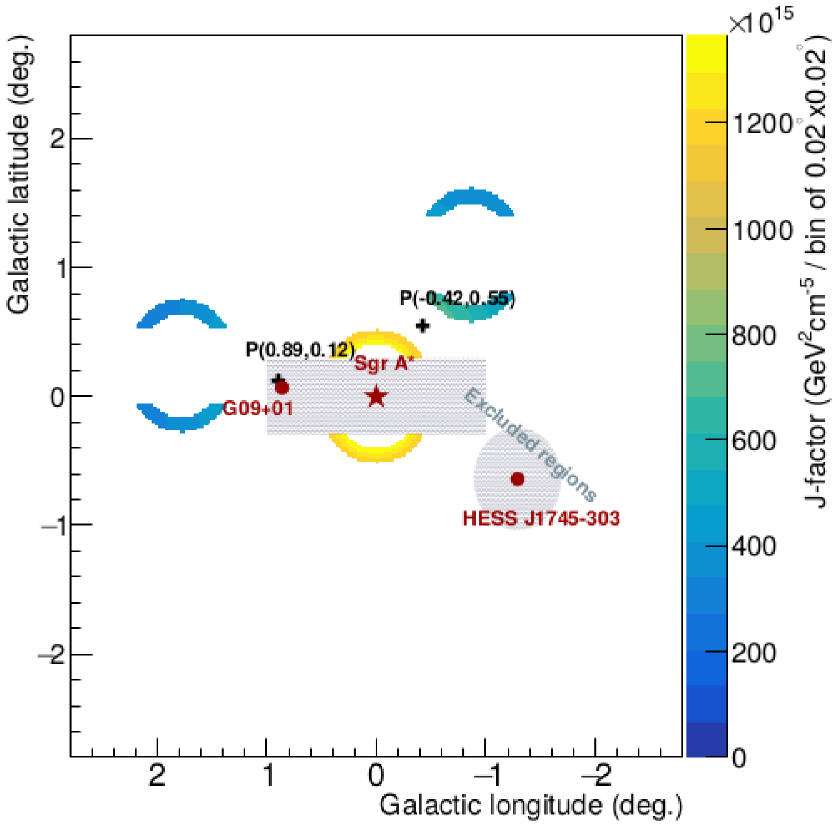
2nd ROI and corresponding OFF regions

ON and OFF regions

254h of data between 2004 and 2014 (H.E.S.S. I phase)
Telescope pointing positions between 0.5° and 1.5° from the GC
Mean zenith angle of 19°

ROIs are annuli of 0.1° width from 0.3° to 1° from the GC

2D maximum likelihood method



2nd ROI and corresponding OFF regions

2D maximum likelihood method

$$\mathcal{L}_{\rm ij}(\mathbf{N}_{\rm ON},\mathbf{N}_{\rm OFF},\alpha|\mathbf{N}_{\rm S},\mathbf{N}'_{\rm S},\mathbf{N}_{\rm B}) = \frac{(N_{\rm S,ij}+N_{\rm B,ij})^{N_{\rm ON,ij}}}{N_{\rm ON,ij}!}e^{-(N_{\rm S,ij}+N_{\rm B,ij})}\frac{(N'_{\rm S,ij}+\alpha_i N_{\rm B,ij})^{N_{\rm OFF,ij}}}{N_{\rm OFF,ij}!}e^{-(N'_{\rm S,ij}+\alpha_i N_{\rm B,ij})}$$

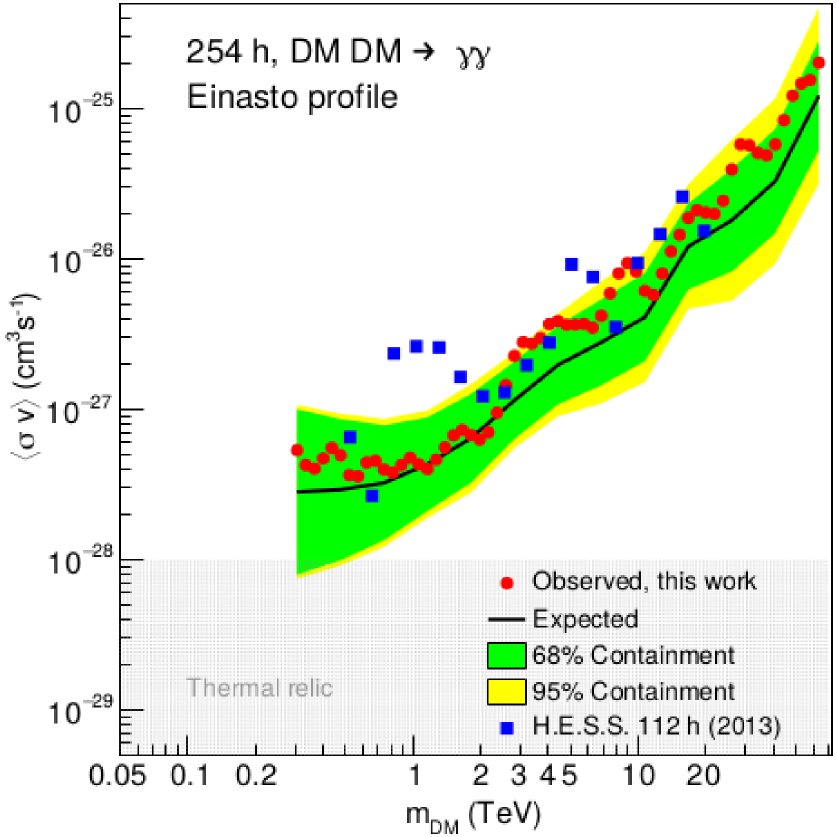
- spatial bins *i*
- energy bins *j*
- N_S is the number of signal events expected in the ON regions
- N'_S is the number of signal events expected in the OFF regions
- N_B is the number of background events expected in the ON regions

- Poisson terms for both ON and OFF
- here $\alpha_i = 1$ by construction

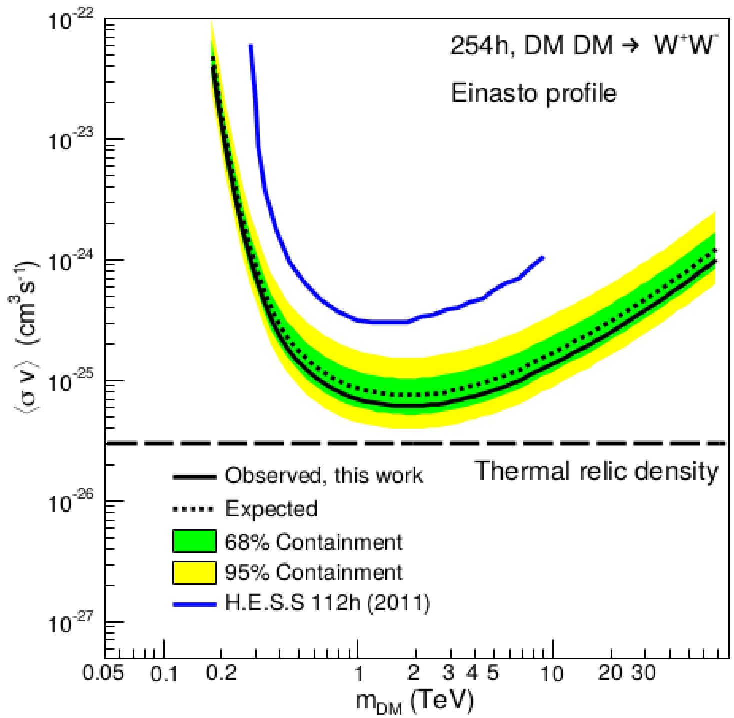
Results: $\gamma\gamma$ channel

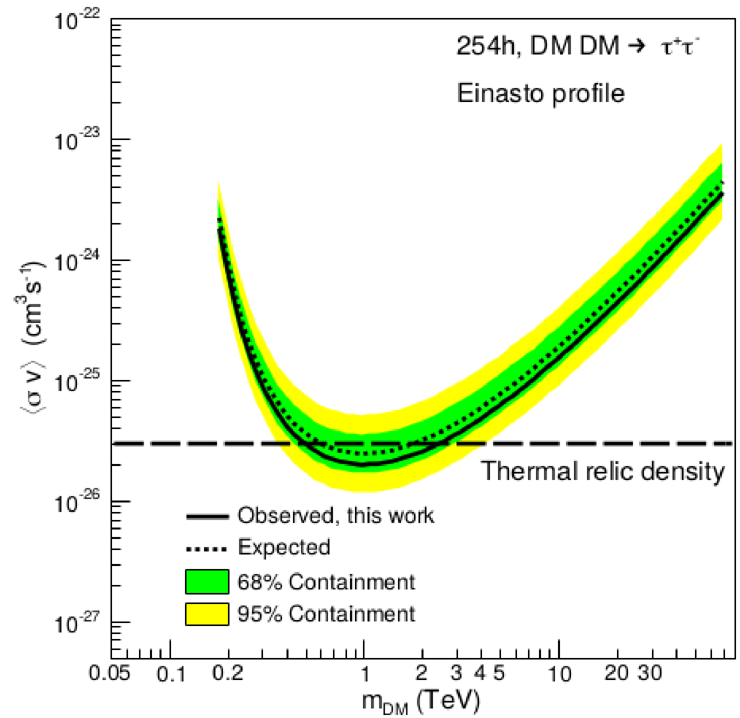
Worth noticing that, compared to the previous 112h publications, the limit at 1 TeV was improved by a factor 6! From which:

- 1.4 comes from the improved photon statistics
- 1.8 comes from the likelihood analysis method using both ON and OFF Poisson terms
- 1.3 comes from the 2D likelihood analysis



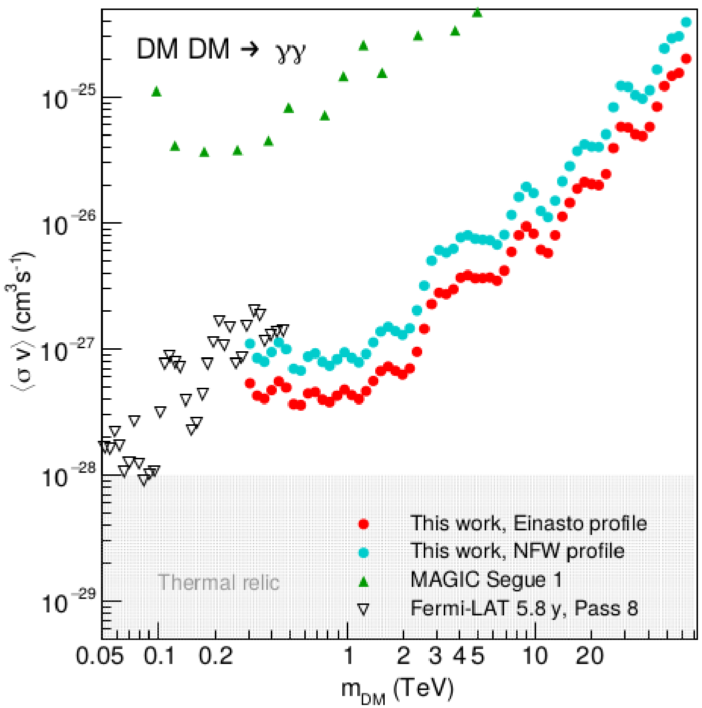
Results: other channels

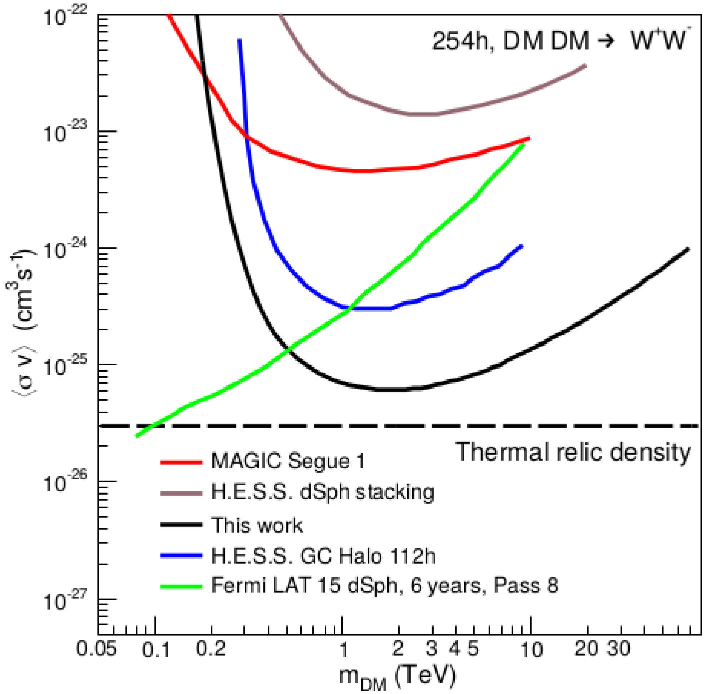




In the $\tau^+\tau^-$ channel, limits start to reach the thermal relic density !

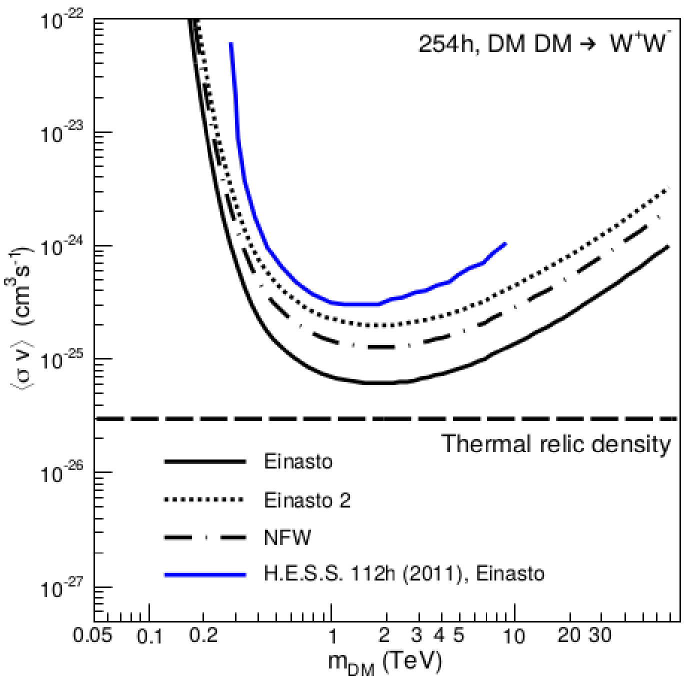
Comparisons with other limits

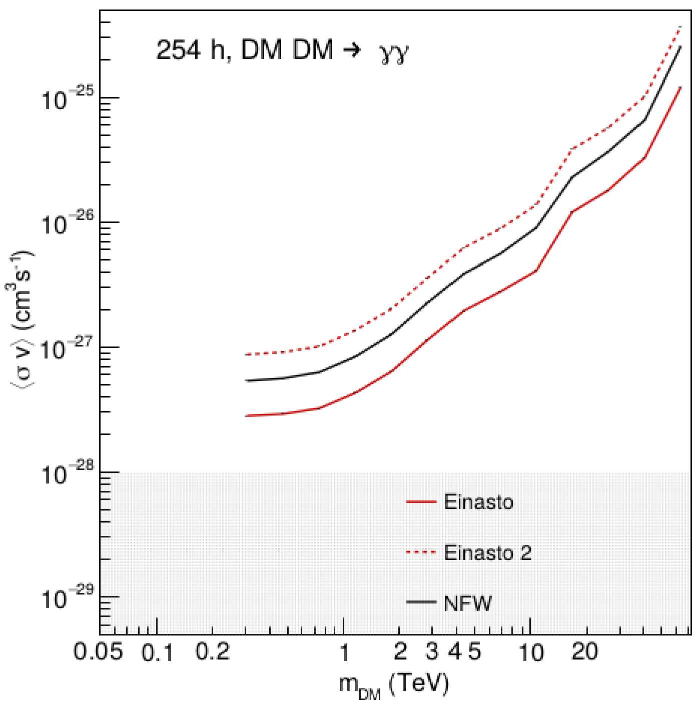




Best limit achieved around 1 TeV.
Limits at the level of Fermi-LAT at a few hundred GeV in the $\gamma\gamma$ channel.

Dependency on the DM profiles





Caveat: uncertanties on the Galactic halo profile play a major role!